REPORT ON STOMATOPOD LARVAE, CUMACEA AND CLADOCERA

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WITH TEN TEXT-FIGURES

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INTRODUCTION.

The three widely separated groups which form the subject of this report are brought together here as a matter of convenience because each is represented by only a few species.

My thanks are due to Dr. W. T. Calman, F.R.S., of the British Museum, for the opportunity of studying the collections, and also for much helpful advice and encouragement; also to Dr. I. Gordon, of the British Museum, for assistance with the literature of the subject; to Mr. F. S. Russell, who accompanied the Expedition, for information regarding the distribution of the various species in the plankton; and to Mr. F. A. McNeill, of the Australian Museum, who is preparing the report on the adult Stomatopods, for information regarding the distribution of these forms. Finally I must express my thanks to the Director and Trustees of the British Museum for allowing me to carry out the examination of the material in the Museum.

STOMATOPODA.

THE CLASSIFICATION OF STOMATOPOD LARVAE.

The presence in the collection of larvae representative of the majority of the genera of Stomatopoda has rendered possible a consideration of the relations of the generic characters of the larvae to those of the adults. In this connection I have had the opportunity of studying the large collection of larvae in the British Museum.

Our knowledge of the larval Stomatopoda is mainly due to the work of Claus (1872), Brooks (1886), Hansen (1895 and 1926), and Giesbrecht (1910); the last gives a very good account of the earlier work.

The older workers were very impressed by the way in which the *Alima* larvae of *Squilla* differ from the *Erichthus* larvae of the other genera, but Claus (1872) showed that transitional forms occur, and to these he gave the name *Alimerichthus*. Brooks (1886) also held that there was a wide difference between *Alima* and *Erichthus*, and suggested that, when found, the larvae of the new genus *Coronida* would fill the gap (there was then only one species of *Coronida*), but when these larvae were recognized they did not fit into this scheme.

The first attempt to draw up a key to the Stomatopod larvae was made by Bigelow (1895), but unfortunately he based his key on the general appearance of the forms, which is very deceptive, so that it is of little help towards a natural arrangement; moreover he included such groups as *Squillerichthus* and *Alimerichthus*, which, with our present knowledge, cannot be regarded as larval genera.

A great step was made by Hansen (1895), but his methods of identifying the larvae, excellent as they are, result in a misleading arrangement of the genera, with *Alima*, as is usual, separated from the *Erichthus* forms, which then fall into two groups, *Lysiosquilla* and *Coronida* on the one side, and *Gonodactylus*, *Odontodactylus* and *Pseudosquilla* on the other. This arrangement is the result of Hansen's choice of the shape of the three thoracic appendages which follow the raptorial claw* as one of the chief characters.

The relationship of the genera of adult Stomatopoda has always been an intricate problem; an attempt to elucidate the matter was made by Brooks in his "Challenger" report, but later workers have been unable to agree with his conclusions. The introduction of the larval forms into arguments on this subject has, in the past, always resulted in confusing the issue. I have endeavoured to show in a "key" that the larvae fit naturally into such a scheme as is advocated for the adults by Kemp (1913), who says that the genera fall into two groups, with *Squilla*, *Pseudosquilla*, *Lysiosquilla* and *Coronida* on the one hand, and *Gonodactylus* and *Odontodactylus* on the other. This is quite different from the arrangement given above, where *Pseudosquilla* is allied to *Gonodactylus* and *Odontodactylus*.

As regards the course of development, the *Erichthus* larvae are also divided into groups; here again *Pseudosquilla* is brought into proximity with *Gonodactylus* (Calman). The other group is formed by *Lysiosquilla* and *Coronida*, which show a lengthy metamorphosis, involving the transformation of the biramous thoracic appendages into the typical chelate limb.

* Perhaps it is as well to point out here that Hansen, in the "Plankton" report, calls these appendages "Greiffüsse" 1, 2 and 3; in the "Siboga" report he calls them thoracic legs 2, 3 and 4. Calman (1909) calls them thoracic appendages 3, 4 and 5; and it is this last method that I shall adopt here.

It would not appear that the alliance of *Pseudosquilla* with *Gonodactylus* carries any great weight, for, as Calman (1909) has pointed out, *Alima* larvae themselves belong to the same group, that is to say, they hatch at the same stage.* The difference here is really therefore between *Lysiosquilla* and *Coronida* on the one hand, and *all* the other genera on the other. This difference appears to be of little phylogenetic importance, for it is probable that the primitive life-history was like that of a *Lysiosquilla*, and then the provision of more yolk in the egg resulted in the *Squilla* and *Pseudosquilla* type of life-history, where emergence from the egg takes place at a later stage of development, the anterior appendages developing directly and the posterior ones being suppressed; such a condition might have arisen on several independent occasions. The possibility of the genera *Lysiosquilla* and *Coronida* showing a return to the earlier form, by the provision of less yolk in the egg, and thus being revertive rather than primitive, cannot be disregarded.

With regard to the separation of the forms *Alima* and *Erichthus* on morphological grounds, the only constant difference yet recorded is that first noted by Brooks (1886), and quoted both by Giesbrecht (1910) and by Hansen (1926). Brooks pointed out that in *Alima* there are always more than four intermediate denticles between the submedian and lateral denticles of the telson, whilst in the larvae of the other genera (*Erichthus* forms) there is only one such intermediate denticle. It does not seem that this character, which is only regarded as of generic value in the case of the adult *Squilla*, warrants the segregation of the *Alima* and the *Erichthus* forms such as has always taken place in the past.

The key to the genera of the larvae is intended for use with larvae of all stages, and shows the following points:

(1) That the larvae can be classified in the same way as Kemp has suggested for the adults.

(2) That the characters of the larvae bear a very definite relation to those of the adults, the likeness to the adult becoming greater at each successive stage.

(3) That the difference between the *Alima* and the *Erichthus* types is not fundamental as has been supposed, but is really a minor generic modification.

KEY TO THE GENERA OF LARVAL STOMATOPODA.

(1) Larvæ hatch either with biramous thoracic appendages, or with the raptorial claw developed and no appendages on the third, fourth and fifth segments of the thorax. In the raptorial claw the upper margin of the propodus is finely pectinate and the ischio-meral articulation is always terminal.

(*a*) Larvæ hatch with the raptorial claw developed; the so-called "hand" of the fourth thoracic leg is oblong and generally longer than broad, and scarcely bigger than that of the fifth leg.

i. Telson with more than four intermediate denticles between the submedian and lateral denticles . . . . *Squilla.* [*Alima.*]

ii. Telson with less than four intermediate denticles between the submedian and the lateral denticles . *Pseudosquilla.* [*Pseuderichthus.*]

* It would appear that no Stomatopoda hatch at a stage earlier than the well-known early stages; Lister's so-called metanauplius of a Stomatopod, which has been described and figured in several text-books, has been shown by Gurney (1924) to be a larval decapod.

(*b*) Larvæ hatch with biramous thoracic appendages (*Erichthoidina* stage), which undergo a transformation into the typical chelate form. The "hand" of the fourth thoracic appendage is rounded, often broader than long, and more than twice as big as that of the fifth leg.

i. Propodus of the raptorial claw broad and the dactylus slightly inflated at the base . . . . . *Coronida*. [*Coronideriehthus*.]

ii. Propodus of the raptorial claw slender and no trace of inflation at the base of the dactylus . . . *Lysiosquilla*. [*Lysioerichthus*.]

(2) Larvæ always hatch with the raptorial claw developed and no appendages on the third, fourth and fifth segments of the thorax. In the raptorial claw the upper margin of the propodus is never pectinate, and in later stages the ischiomeral articulation becomes situated at a point in advance of the proximal end of the merus.

(*a*) The spines of the telson are greatly elongated *Odontodactylus*. [*Odonterichthus*.]

(*b*) The spines of the telson are not greatly elongated *Gonodactylus*. [*Gonerichthus*.]

THE REFERENCE OF LARVAE TO ADULT FORMS.

The only really sure way of referring a larva to its appropriate adult is by the use of intermediate post-larvae which combine certain characters of the larva with others of the adult; unfortunately post-larvae are entirely lacking in the present collection.

One reference has been attempted, however, by the methods which are discussed by Hansen (1895). More recently Calman (1917) has pointed out that the number of epipodites present on the thoracic appendages varies in the Atlantic species of *Squilla*, and this has provided a useful check on the reference of larvae to the adults.

The following is a list of some species of larvae and adults which have been linked up :

Larva.	Adult.	Epipodites. Larva.	Epipodites. Adult.	Authority.
No larval name	*S. desmaresti*	4	4	Giesbrecht (1910).
,, ,,	*S. mantis*	5	5	,, ,,
,, ,,	*S. empusa*	5	5	Brooks (1879).
A. hyalina	*S. dubia*	4	3	Hansen (1895).

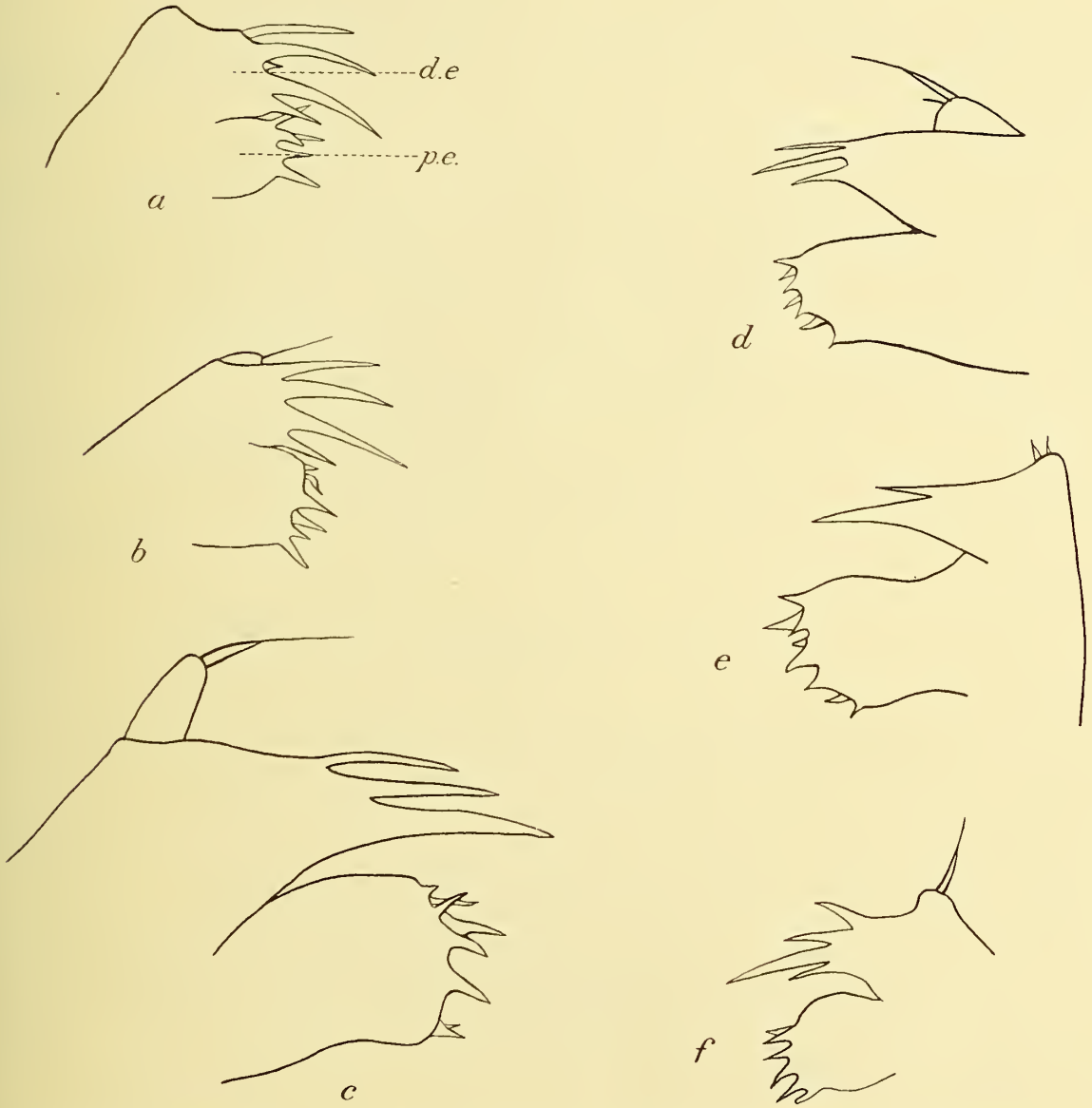
Hansen, who says that *Alima hyalina* is probably the larva of *Squilla dubia*, does so mainly for reasons of geographical distribution, but his suggestion does not appear to be justified by the above evidence. It is not probable that an epipodite would be lost at the post-larval stage, as the general trend in the development of all Stomatopod larvae is towards a gradual assumption of the adult characters.

THE FEEDING MECHANISMS OF THE LARVAE.

The large numbers of individuals of *Lysioerichthus tectus* present in the collection has allowed a study of the mouth-parts and the associated structures to be made; and a comparison of *Lysioerichthus tectus* and *Coronideriehthus rostratus* with representatives of the other genera has demonstrated that the mouth-parts of the larvae show a rather considerable morphological variation, which can be correlated with the methods of feeding and of obtaining food.

Filter-feeding has been stated to occur in the Peracarida, Syncarida and Eucarida and in the larvae of the more primitive Decapods (Cannon and Manton, 1929).

If filter-feeding were to occur in the Stomatopoda it should be looked for in the earliest stages of the larvae of *Lysiosquilla* and *Coronida*, where the raptorial appendages are not



TEXT-FIG. 1.—Maxillules of: *a*, *Lysioerichthus tectus* (M. Edw.), 4-mm. stage; *b*, *Coronid-erichthus rostratus* (Borradaile), 4-mm. stage; *c*, *Lysioerichthus tectus* (M. Edw.), 14-mm. stage; *d*, *Alima emarginata*, Claus, 5-mm. stage; *e*, *Alima emarginata*, Claus, 10-mm. stage; *f*, *Gono-dactylus*, sp., 6-mm. stage. *d.e.*, Distal endite; *p.e.*, proximal endite. All to the same scale.

formed, but an examination of the mouth-parts shows at once that no filter-feeding mechanism can exist, and that the appendages of the thorax are solely natatory in function; it is when the abdomen and its appendages are developed and presumably can take on the swimming function, that the thoracic appendages undergo transformation into the typical chelate form.

The larvae of *Lysiosquilla* and *Coronida*, hatching as they do without raptorial appendages, are clearly at a disadvantage when compared with the larvae of the other genera. A peculiar modification of the maxillule is to be seen in the larvae of these two genera.

Text-fig. 1, *a* shows the maxillule of a 4-mm. *Lysioerichthus tectus*, and it will be noticed that the distal and proximal endites are approximately equal in size ; if there is any difference it is that the distal endite is larger than the proximal one, also the proximal endite is not armed with many spines. The same is true of *Coroniderichthus rostratus ;* Text-fig. 1, *b* shows a maxillule from a 4-mm. stage.

By the time that the 14-mm. stage is reached in *Lysioerichthus* (see Text-fig. 1, *c*) the proximal endite is becoming more important and is markedly more spinose. On the other hand, at the earliest stage of *Alima emarginata* (Text-fig. 1, *d*), 5 mm. specimen, the proximal endite is already larger than the distal endite and is armed with a considerable number of spines. This difference in size becomes even more pronounced by the time that the 10-mm. stage is reached (Text-fig. 1, *e*) ; *Gonodactylus* (Text-fig. 1, *f*) and *Pseudosquilla* (see Giesbrecht, 1910) show the same thing.

I wish to suggest, therefore, that in the larvae of *Lysiosquilla* and *Coronida* the maxillule in the earliest stages takes no part in the mastication or maceration of the food, but serves the purpose of holding the food against the mandibles ; the elongation of the distal endite of the maxillule appears to be a particular modification for this purpose, whereas in the other genera the grasping function is taken on by the chelate thoracic appendages at a very early stage.

A comparison of the maxillule of *Lysioerichthus tectus* with that of the zoea of *Carcinus maenas* appears to confirm this view. Williamson (1903) gives some figures of the maxillule of the zoea of *Carcinus ;* in this case the distal endite retains its dominance over the proximal endite in the later stages of development, but at the same time, in the early stages the distal endites of the maxillules of *Carcinus* and *Lysioerichthus* show a marked resemblance such as might well be concerned with a similarity of function. The feeding mechanism of the zoea of *Carcinus* is, however, known and has been briefly described by Dr. Lebour (1928), who points out that in her experiments no larvae of the Brachyura were reared on a vegetable diet alone, and that " the larvae of oysters and other molluscs, worms and echinoderms are apparently the natural food, and quite small zoeae have been seen to eat them, smashing up the mollusc shells and echinoderm spines with their powerful mandibles, whilst holding the food partly with the other mouth-parts and partly with the abdomen curled under the body." It would appear safe to assume that *Lysiosquilla* and *Coronida* larvae use their mouth-parts in a similar manner.

SYSTEMATIC NOTES.

Many of the larvae occurred at most of the stations, so that no station list is given as it would be of little value. Any points of interest in the occurrence or distribution of the species are noted under the species concerned. Mr. Russell's forthcoming paper on the Zooplankton will deal with the quantitative aspect of the distribution and such details are omitted here. The station numbers refer to the list already published (Russell and Colman, 1931).

Squilla, J. C. Fabricius.

1. *Squilla*, sp.

[*Alima emarginata*, Claus.]
[*A. emarginata*, Claus, 1872.]
[*A. emarginata*, Lanchester, 1906.]

Occurrence.—With a few exceptions this species was found regularly at the weekly plankton station ; it was also taken at most of the other stations both inside and outside the reef.

Remarks.—Many specimens in all stages of the life-history were taken all the year round, and this points to the species having a prolonged larval life.

Lanchester's figure is hardly typical, especially as regards the telson ; and the spinulation of the carapace, of which he gives details, varies greatly, the arrangement as shown by Claus (fig. 33) not being arrived at until a length of 25–30 mm. is reached.

The largest specimen in the collection measures 35 mm. in length including the rostrum, and it closely resembles Claus's figure ; it has one less spine showing beneath the skin of the dactylus of the raptorial claw and seven spines on the exopodite of the uropod. Claus's specimen measured 44 mm.

The first four thoracic appendages bear epipodites.

2. *Squilla*, sp.

[*Alima pyramidalis* (Lanchester).]
[*Alimerichthus pyramidalis*, Lanchester, 1903.]
[*Alimerichthus unidens*, Lanchester, 1903.]
[*Alimerichthus a*, Tattersall, 1906.]

Occurrence.—This species was found at the weekly station during the greater part of the year, being taken for the first time on 6th September, 1928, and for the last time on 17th July, 1929 ; but it was most common from November to June. It was also found at most stations inside the reef but only once outside it, namely station L, outside Papuan Pass.

Remarks.—I am unable to agree with Lanchester and Tattersall that the forms which they describe are really three different species. The characters used by these authors to differentiate the three species resolve themselves into—

(1) The position of the subordinate spines on the carapace,

(2) The spinulation of the telson,

(3) The stage of development reached compared with the length of the specimen.

An examination of the large number of specimens of this type of *Alima* collected by the Expedition shows that all these three characters are subject to a great amount of variation. In the first place, forms which appear to be exactly alike in other respects may have no medio-lateral spine on the carapace, or they may possess one or two such spines. Again the spinulation of the telson varies ; Tattersall, in describing *Alimerichthus a*, says that between the submedian and the intermediate spines there are seven intermediate denticles ; his figure, however, shows only six such denticles ; and in the Barrier Reef material the number of intermediate denticles is seen in some cases to differ on the two sides of the same telson. Then as to comparative size ; Lanchester observed that the quite small specimen, which he called *Alimerichthus unidens*, showed the same stage

of development at 12·5 mm. as was shown by *A. pyramidalis* at 17 mm. He noted, too, that *A. unidens* had one fully-developed spine on the dactylus as well as the terminal one. In the Barrier Reef material the degree of the development of the spines on the dactylus appears to be particularly subject to variation ; the development of these spines might well depend on a considerable number of factors, both internal and external. Again, with regard to size, Tattersall points out that *Alimerichthus a* is at a later stage at 9 mm. than *A. unidens* at 12 mm. or *A. pyramidalis* at 16 mm., and remarks that it evidently belongs to a smaller species of adult than do the other two species. On the other hand, when describing a form which he calls *Alima a* he says that some forms at 19 mm. are more developed than some at 27 mm., but apparently he is satisfied that the two forms belong to the same species ; if this is so, there would appear to be no justification for making *Alimerichthus a* a new species on account of its size.

In support of the view that the Barrier Reef forms all belong to one species, it may be pointed out that in most cases the larvae seemed to be forming homogeneous swarms in the plankton.

The comparatively early assumption of advanced characters by small larvae is typical of the *Alimerichthus* forms, and indeed of *Alima* larvae in general ; the prolongation of larval life which appears to have taken place in this genus comes at the end of the larval stage, when many advanced characters have been assumed, not at the beginning.

The largest forms were found in February and March, 1929, when specimens measuring 18 mm. were taken.

3. *Squilla*, sp. (? *lata*, Brooks). (Text-figs. 2 and 3.)

[*Alima*, sp.]

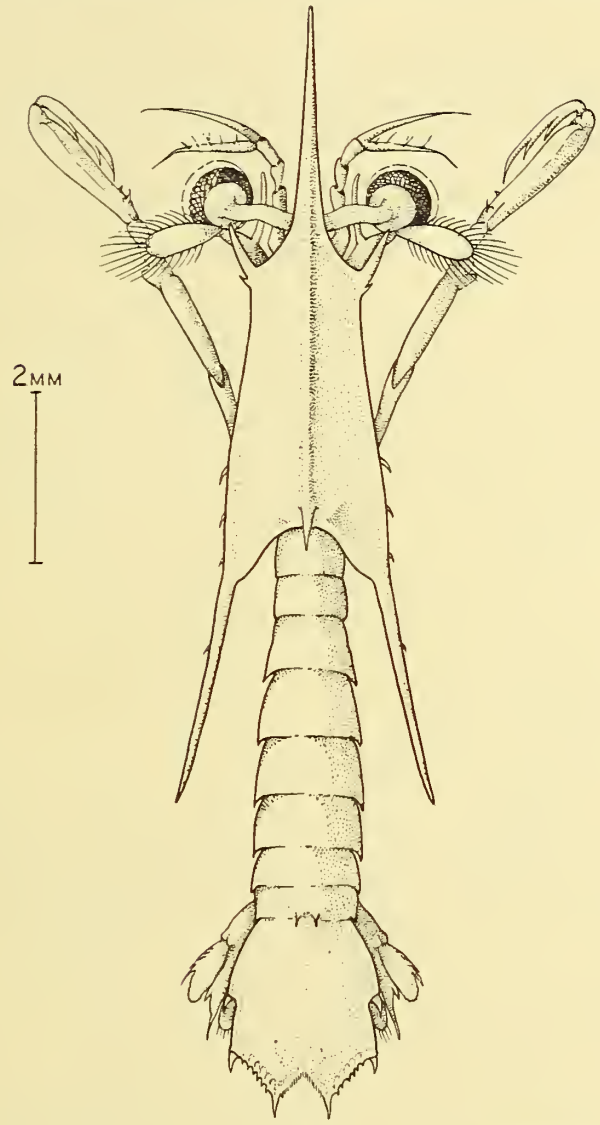
Occurrence.—This species was found at many stations, and nearly all the year round at the weekly station, but it was rare in July, August and September. It was also taken at Stations XLIII, XLIV, XLIX, inside the Reef, and at Station XLV outside it ; this species did not occur in Trinity Opening.

Remarks.—This species of *Squilla* larva does not appear to have been described before ; as, for reasons given below, it is thought that this form may be the larva of *Squilla lata*, Brooks, a brief description is given.

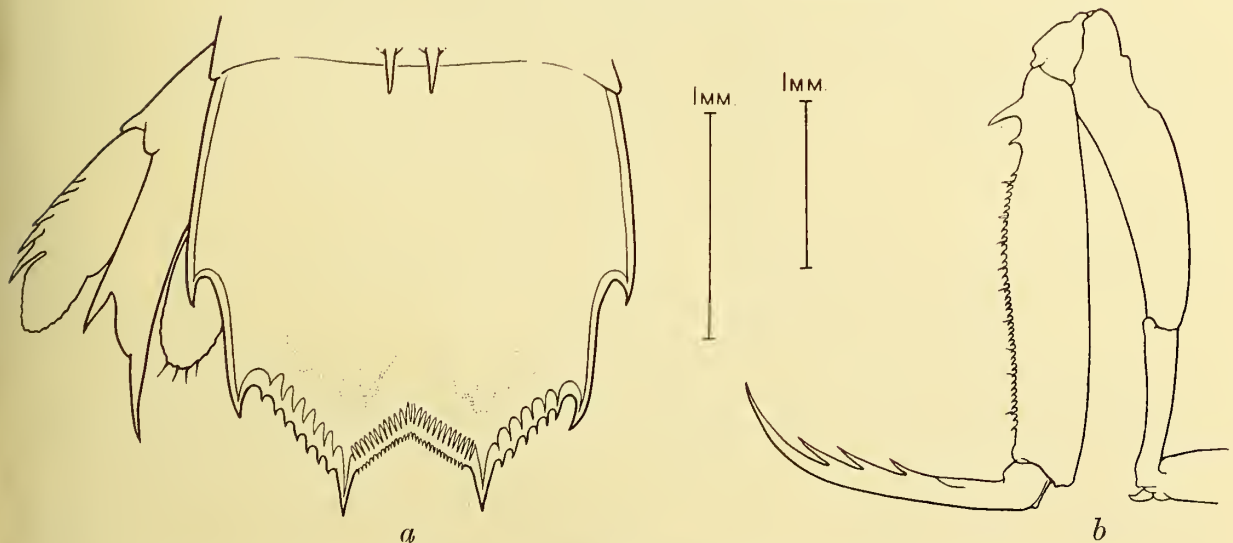
Few of the larvae exceed 16 mm. in length, and at this size appear to be ready for the final moult ; the largest specimens are 18 mm. in length.

In general appearance this species resembles *Alima longicaudata*, Jurich (1904).

The carapace, which is three times as long as it is broad, leaves the last three segments of the thorax exposed dorsally. The rostrum is not as long as the antennal flagella, or as long as the posterior lateral spines ; ventrally it bears four spines. The anterior lateral spines are short and point forward, each has one ventrally directed spine beneath. The lateral margins of the carapace are armed posteriorly, just in front of the posterior lateral spines, with three ventrally directed spines ; the posterior lateral spine itself bears a ventrally directed spine. The "zoea" spine is small, and the carapace only slightly raised near its base. The posterior margin of the carapace is slightly inflected downwards. A dorsal carina, which is not very well marked, traverses the length of the carapace from the rostrum to the "zoea" spine. The only other *Alima* larvae with such carinae are *A. bidens*, Claus, and *Alima a*, of Tattersall.



TEXT-FIG. 2.—*Alima*, sp (? *Squilla lata*). Dorsal view.



TEXT-FIG. 3.—*Alima*, sp. (? *Squilla lata*). *a*, Telson and left uropod ; *b*, raptorial claw.

In a specimen 14 mm. long, four of the thoracic appendages have epipodites, and all the appendages are well developed.

The raptorial claw (Text-fig. 3, *b*) has a rather inflated propodus and a slender dactylus; in well-grown specimens four spines, including the terminal one, are fully-formed, and two more are apparent beneath the skin. A slightly earlier stage is figured.

There are six spines on the exopodite of the uropod (Text-fig. 3, *a*).

The submedian carinae of the abdominal segments end in spines only in the sixth segment.

For the following reasons it is suggested that this larva belongs to *Squilla lata*, Brooks :

(1) Six teeth on the dactylus of the raptorial claw.

(2) Only the submedian carinae of the sixth abdominal segment end in spines.

(3) The similarities seen in the telson and in the uropods.

The only discrepancy between the two is that in the larva there are no serrations on the inner side of the spines of the uropods, such as are present in the adult.

Pseudosquilla, Dana.

4. *Pseudosquilla*, sp.

[*Pseuderichthus affinis*, Borradaile.]
[*Erichthus*, sp., Claus, 1872.]
[*Pseuderichthus affinis*, Borradaile, 1907.]

Occurrence.—This species was present in the plankton in small numbers only. At the weekly station it was found at intervals throughout the year, but was absent from February to June. Other localities were Stations VIII, XI, XLIV, XLIX, all inside the reef. On 16th November, 1928, specimens were taken in the tow-nets in the Low Isles Anchorage.

Remarks.—Although Borradaile assigns this species to the genus *Pseuderichthus* with a query, his determination appears to be correct.

The largest specimens are somewhat more advanced than that figured by Claus (fig. 33) ; his specimen was 8 mm. long ; the Barrier Reef examples are 10 mm. in length.

The uropods are, in this stage, as long as the telson and the spines of the uropods somewhat longer than this. The five thoracic appendages are well developed and the last three are just becoming biramous. There is no trace of any spines on the dactylus of the raptorial claw and its merus is somewhat inflated. The pectination of the propodus is very conspicuous.

Lysiosquilla, Dana.

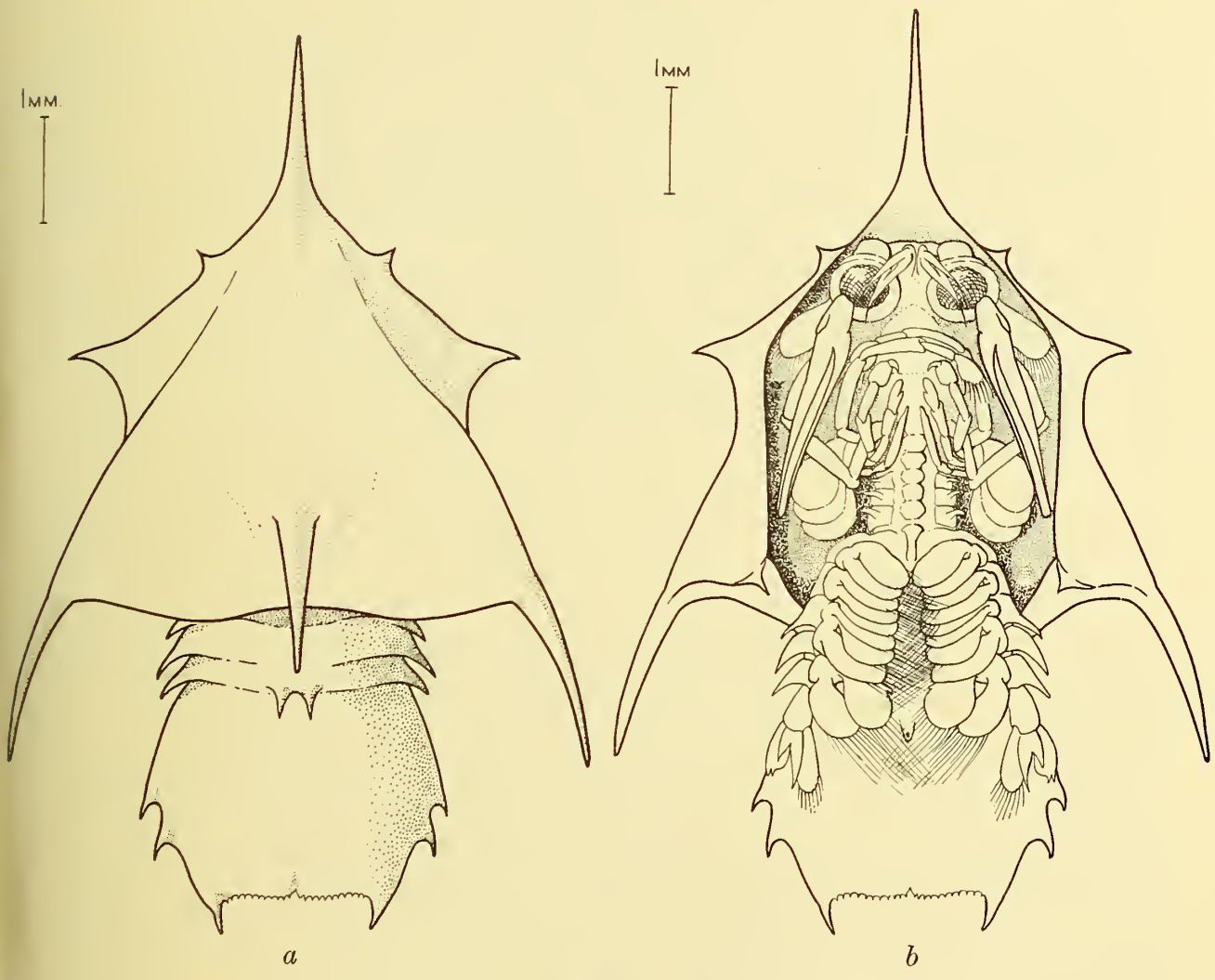
5. *Lysiosquilla*, sp. (Text-fig. 4.)

[*Lysioerichthus tectus* (M. Edw.).]
[*Erichthus tectus*, Milne Edwards, 1837.]
[*Erichthus tectus*, Dana, 1852.]

Occurrence.—This form occurred for a short time during the year, and was taken at the weekly station from 21st November, 1928, until 18th February, 1929 (Stations XXVII, XXX, XXXIII–XLII inclusive). It was not found at any other locality.

Remarks.—This species does not appear to have been found since it was first described by Milne Edwards, who gives a brief description of this form and says that

it is very like *Erichthus triangularis*, M. Edw., from which it is differentiated by the possession of a medio-lateral spine on the carapace. Unfortunately he does not figure this species, but Claus (1872) gives good figures of *E. triangularis*, M. Edw. (not *E. triangularis*, Brooks), and there is little room for doubt in the determination of this



TEXT-FIG. 4.—*Lysioerichthus tectus* (M. Edw.). *a*, Dorsal view ; *b*, ventral view.

species. As this species has not been figured before, figures of both dorsal and ventral views are given.

The great size of the carapace is most striking. In the largest specimen, of which the total length is 15 mm., there are no traces of teeth on the dactylus. All the *Lysiosquilla* larvae which were collected belong to this species, and it is peculiar that the larvae of *Lysiosquilla maculata* were not found.

A very large number of forms in all stages were taken, and they have formed the basis of the notes on the mouth-parts made above.

Coronida, Brooks.

6. *Coronida*, sp.

[*Coronid*erichthus *rostratus* (Borradaile).]
[*Erichthus*, sp., Claus, 1872.]
[*Erichthus* (*? Odonterichthus*) *rostratus*, Borradaile, 1907.]

Occurrence.—This species was first found at Station VIII (Trinity Opening). Afterwards it occurred at the weekly station (Stations XIV, XXII, XXIII, XXXIV, XLII, LII), and also at Stations XLIII, XLVI, and XLIX, all inside the reef. On 18th October, 1928, this species was taken in the Low Isles Anchorage plankton.

Remarks.—The specimens collected by the Expedition are undoubtedly *Coronid-erichthi*. They are identical with both the figures given by Claus and with the actual specimens collected by the "Sea-Lark" Expedition.

The pectination of the merus of the raptorial claw and the shape of the third, fourth and fifth thoracic appendages preclude the possibility of these forms belonging to an *Odontodactylus*, and the inflated propodus and rather swollen dactylus of the raptorial claw show that it does not belong to a *Lysiosquilla*.

The specimens are nearly all small, the largest being between 10 mm. and 12 mm.

Gonodactylus, Latreille.

7. *Gonodactylus*, sp.

[*Gonerichthus*, sp.]

Occurrence.—This species did not occur on many occasions. It was taken occasionally at the weekly station from August, 1928, until January, 1929 (Stations V, VII, XXI, XXII, XXXVI, XXXIX). Other localities were: Trinity Opening (Stations VIII and XI), inside Papuan Pass (Station XLIX). It was not found outside the reef.

Remarks.—The specimens of *Gonerichthus* larvae all belong to one species, and as *Gonodactylus chiragra* is so common on the reef it is highly probable that they are the larvae of this form. Of the forms previously described this species is most like that shown by Brooks (1886), pl. xii, fig. 5. The greatest point of similarity is that there is no "zoea" spine. Although Brooks's form came from the Atlantic, he states that a similar form was found in the Celebes sea, and of this he figures the telson. The suggestion that these two forms belong to the same species seems hardly feasible, as no one species of *Gonodactylus* occurs in both the Atlantic and the Pacific. The telson of the Barrier Reef specimen is very similar to that of the one from the Celebes sea, and these two specimens probably belong to the same species.

If these forms are the larvae of *G. chiragra*, it may be that the Atlantic form described by Brooks is the larva of *G. Oerstedii*, Hansen.

The largest specimen is 15 mm. in length. There is no "zoea" spine. The rostrum has six spines on the ventral surface. There are a few spines (not pectination) on the proximal part of the propodus of the raptorial claw; the dactylus is very slender. The outer spine of the uropod is much elongated, the inner almost suppressed. The uropod is not as long as the telson; the telson is slightly longer than broad; the spines of the telson are as long as those shown in *Odonterichthus tenuicornis*, Jurich (1904, pl. xxviii,

fig. 4), or even a little longer; this would appear to be contradictory to what is stated in the key, but Hansen (1926) expresses himself doubtful as to the correctness of Jurich's determination of the genus, so that this point has been disregarded.

CUMACEA.

INTRODUCTION.

The collection of Cumacea is small, but nevertheless provides material of interest. It has been possible to name seven species, and two others appear to be represented; three of the determinable species are regarded as new. Owing to the specimens having been preserved in formalin they have suffered to a large extent from decalcification; several are so damaged that identification is impossible, and it is probable that when further material becomes available, the descriptions of the new species may require revision, at least as far as the carapace is concerned.

The small size of the collection is largely due to the infrequency with which plankton collections were made at night. Only on one occasion were Cumacea found during the day, and that was at Station XXIX, where they were taken in the bottom stramin net.

The Cumacea previously known from Australian waters were reviewed by Hale in 1928, and it is significant that not one of the species recorded by him was found by the Expedition. This is no doubt due to the fact that the Eastern coast of the Continent seems to have been left untouched by previous collectors. It appears that the Barrier Reef Cumacean fauna bears some affinity to that of New Zealand on the one hand, and to the more northern fauna on the other; for *Cyclaspis levis* and *Cyclaspis similis*, hitherto known from New Zealand, were both found by the Expedition. *Nannastacus suhmii*, which was also taken, was previously known from the Philippine Islands; and it is noted later that certain species of the genus *Cyclaspis*, which it has not been possible to name, bear affinities to species of that genus previously recorded from North-Western Australia.

There is a very apparent difference between the Cumacean fauna of the Lagoon and that of the deeper waters outside it. At Stations XXI and XXIX *Sympodomma australiensis* and *Campylaspis pileus* both occurred, no other species being taken. In the Lagoon, on the other hand, neither of these species was taken on any occasion, although several species were taken more than once.

LIST OF STATIONS AT WHICH CUMACEA WERE OBTAINED.

Date.	Station.	Time.	Net.	Depth.
1.x.28	Low Isles Anchorage	Night	Medium	Surface.
22.x.28	XXI	8.40–9.10 p.m.	Stramin	22 m.*
16.xi.28	Low Isles Anchorage	7.30 p.m.	Coarse	Surface.
24.xi.28	XXIX	2.17 p.m.	B.S.N.	200 m.
29.xi.28	Low Isles Anchorage	Moonlight	Coarse	Surface.
28.vi.29	,, ,,	Night	Medium	,,

* This is the fishing depth. For details of all Plankton Stations outside the Lagoon Russell and Colman (1931) should be consulted.

SYSTEMATIC NOTES.

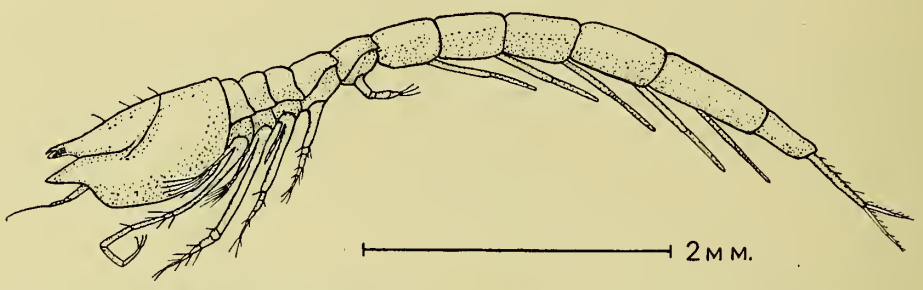
SYMPODOMMATIDAE.

Sympodomma, Stebbing.

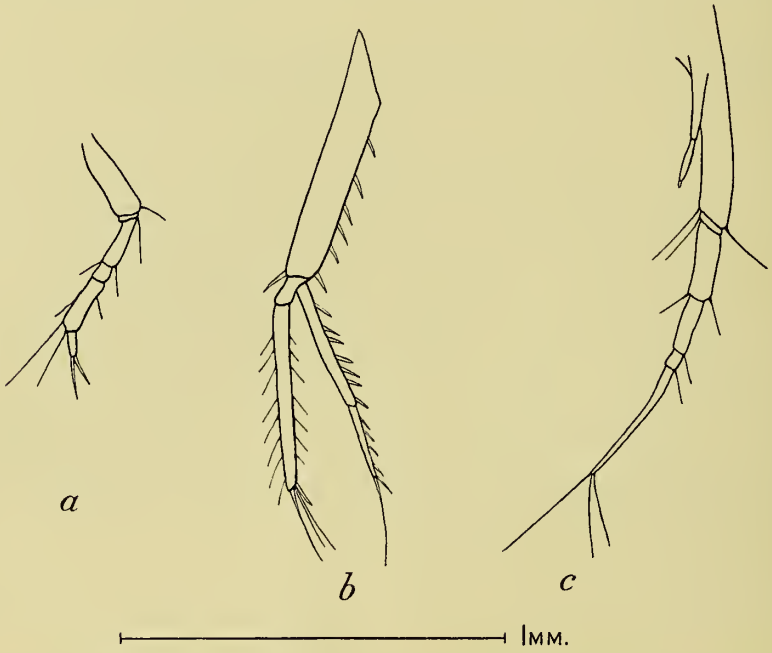
8. *Sympodomma australiensis*, n. sp. (Text-figs. 5 and 6.)

OCCURRENCE.—Stations XXI and XXIX.

DESCRIPTION OF A FEMALE 7 MM. IN LENGTH.—The body is slender and the uropods are elongated.



TEXT-FIG. 5.—*Sympodomma australiensis*, n. sp. Male. Lateral view.



TEXT-FIG. 6.—*Sympodomma australiensis*, n. sp. *a*, Fifth leg of male ; *b*, uropod of male ; *c*, second leg of male.

The carapace (Text-fig. 5) is one-fifth of the total length. It has a marked dorsal ridge, which terminates anteriorly in a sharp tooth over the typical elongated ocular lobe, and the ridge is armed by a few hairs and three or four small denticles, not projections of the carapace, as in *Sympodomma africana*, Stebbing. An antennal notch is present. From the pseudorostral lobes slight keels extend obliquely upwards to the middle crest, which they meet in its middle point. A pigmented eye is present at the extremity of the ocular lobe.

The thorax is slightly longer than the carapace, the cephalothorax forming one-third of the total length. The first leg-bearing segment is very narrow dorsally, the fourth segment is the largest. The three posterior segments of the thorax are as slender as those of the abdomen.

The abdomen is long and slender, and forms two-thirds of the total length. The fifth segment is the longest.

In the uropods (Text-fig. 6, *b*) the peduncle is as long as the telsonic segment. The exopod is slightly shorter than the endopod; the endopod is equal in length to the peduncle. The first joint of the exopod is one-fifth the length of the second joint. The rami and the peduncle are armed with sharp spines, those of the exopod are not, however, as strong as those borne by the endopod and the peduncle.

The first legs are one and a half times the length of the carapace. The basis is four-fifths the length of all the remaining joints together. The ischium is small; the merus and carpus are subequal; the carpus is two-thirds the length of the propodus; the dactylus is four-fifths the length of the propodus.

In the second legs (Text-fig. 6, *c*) the basis is, comparatively, slightly longer than in the first legs; the ischium is reduced to a chitinous ring, the propodus is quite small, the merus and carpus are subequal, and the dactylus is nearly as long as the merus and carpus together. In the third to fifth legs (Text-fig. 6, *a*) the ischium is small but quite distinct.

Remarks.—The males appear to be mature when 8 mm. in length. The pleopods are very long.

This species appears to resemble *Sympodomma weberi* (Calman), but it is much smaller. The two species agree in having no prominent teeth on the dorsal crest of the carapace, but on the other hand, the telsonic segment in *S. australiensis* is triangularly produced between the bases of the uropods, which is not so in *S. weberi*. Also in *S. australiensis* there is only one corneal area with a light pigmentation, whereas *S. weberi* has two distinct corneal areas. The antennal notch is more pronounced than in *S. weberi*.

Bodotriidae.

Cyclaspis, G. O. Sars.

The members of this genus have suffered greatly from the method of preservation, and the sculpturing of the carapace can only be made out with great difficulty, and in some cases not at all. In addition to the species described below there are members of at least two other species in the collection; unfortunately, owing to the state of preservation, it is useless to attempt to describe them. One of them is interesting, as it shows on the first dorsally visible thoracic segment a crest of hairs, similar to those which have been described by Zimmer (1921 *b*) in *Cyclaspis mjöbergi*, Zimmer, *C. supersculpta*, Zimmer, and *C. candida*, Zimmer, all of which come from North-Western Australian waters.

9. *Cyclaspis levis*, G. M. Thomson.

C. levis, G. M. Thomson, 1892; Stebbing, 1913; Calman, 1917.

Occurrence.—29th November, 1928, and 28th June, 1929, Low Isles Anchorage.

Remarks.—Although the two specimens are smaller than those previously described I do not hesitate to assign them to this species.

They are not well preserved, but it is possible to make out the dorsal keel on the otherwise smooth carapace, the proportions of both the parts of the body and of the joints of the limbs are the same as in the specimens previously described.

The long apical seta on the basis of the first leg is very conspicuous; the proportions of the uropods are typical, and their armature is nearly typical, but the hairs on the endopod are comparatively few.

10. *Cyclaspis similis*, Calman.

C. similis, Calman, 1907; Stebbing, 1913; Calman, 1917.

Occurrence.—16th November, 1928, Low Isles Anchorage.

Remarks.—One male and one female were taken. They are both smaller than the specimens of this species previously described. They are not well preserved, but show the chief characters of the species.

Diastylidae.

Dimorphostylis, Zimmer.

11. *Dimorphostylis australis*, n. sp. (Text-figs. 7 and 8.)

Occurrence.—1st October, 1928, 16th November, 1928, and 28th June, 1929, Low Isles Anchorage.

Description of Female 5 mm. in Length.—The carapace (Text-fig. 7, *a* and *b*) forms one-fourth of the total length; it is broader than deep, and has the dorsal surface well arched. The pseudorostrum is small and not very acute. There is a well-marked eye, behind which there is a small flattened area of the carapace, which bears four tubercles; posterior to this the carapace is well rounded and the crest slopes down to the hinder margin. The sides of the carapace are ornamented with two parallel lateral keels; these are not continuous over the crest, but terminate a little distance on either side. The antennal notch is nearly obliterated.

In the thorax there are five free segments, which together are slightly shorter than the carapace; of these the fourth is the largest.

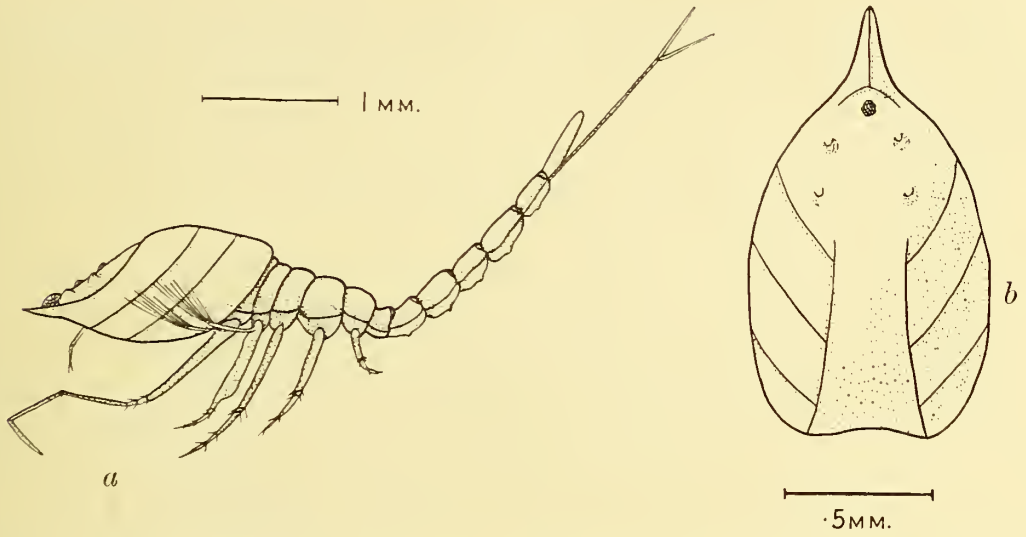
The abdomen is more slender than the cephalothoracic region. The segments of the abdomen are armed ventrally with spines. In the males very strong spines are borne on the third and fourth abdominal segments in a position corresponding to that in which the pleopods are found in the preceding segments.

The telson (Text-fig. 8, *b*) is longer than any segment of the abdomen, but it is only two-thirds the length of the peduncle of the uropods. The anus opens at the distal end of the telson and its opening is guarded by two distinct valves. In the male two distinct post-anal spines are conspicuous. I think that it is highly probable that these spines also occur in the females, but this is not obvious in any of the specimens in the collection.

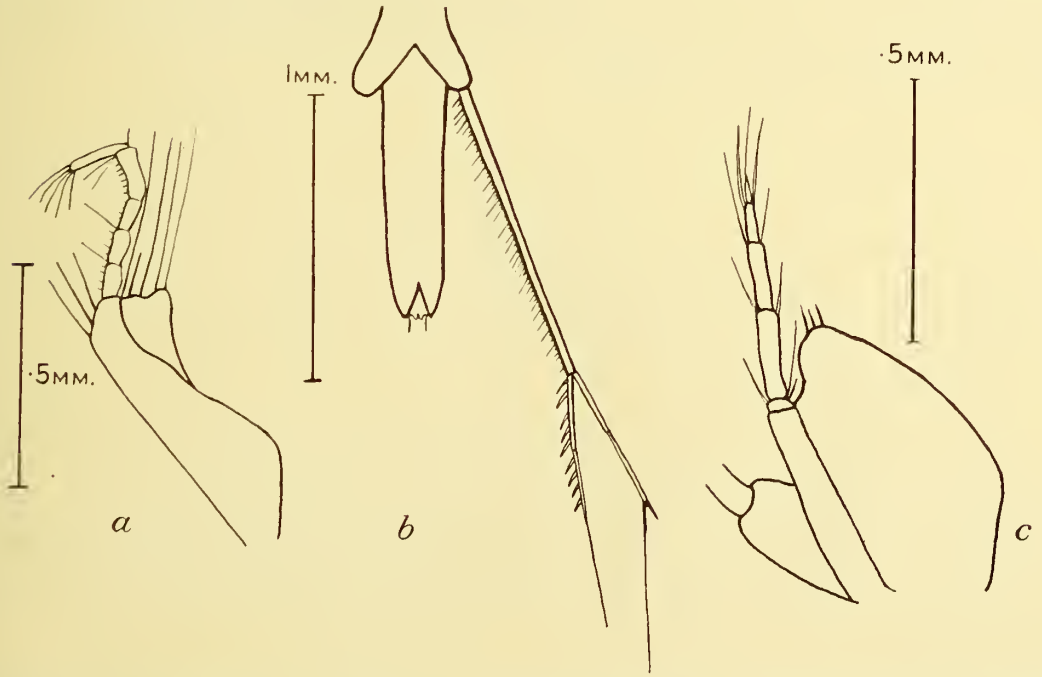
The uropods (Text-fig. 8, *b*) are greatly elongated, being much longer than the telson; the basal joint is armed with spines. The endopod is nearly as long as the exopod. The two basal joints of the endopod are armed with spines; the exopod is unarmed.

The antennule is as long as the carapace; the first segment of the peduncle is larger than either of the two segments. The outer flagellum is longer than the peduncle; the inner much shorter than the outer.

The first legs are less than twice as long as the carapace; the dactylus is less than twice the length of the propodus; the carpus and propodus are subequal.



TEXT-FIG. 7.—*Dimorphostylis australis*, n. sp. *a*, Lateral view of female; *b*, carapace, dorsal view.



TEXT-FIG. 8.—*Dimorphostylis australis*, n. sp. *a*, Third maxilliped of male; *b*, telson and uropod of male, ventral view; *c*, third leg of male.

In the second leg the exopod and endopod are subequal. The second leg is much shorter than the first.

The third (Text-fig. 8, *c*) and fourth legs are slightly longer than the second leg.

The thoracic legs show in a very marked way the lamellar expansion of the basis characteristic of the genus. The basis is produced on the inner side as a large leaf-like expansion which is turned forwards ; terminally it is produced so that it extends further than the distal end of the ischium.

Remarks.—This species is placed in the genus *Dimorphostylis*, founded by Zimmer (1921 *a*) for the reception of a species called *D. asiatica*, Zimmer ; this is done for the following reasons :

(1) The similarity in the sculpturing of the carapace in the two species.
(2) The shape of the basis in the thoracic legs.
(3) The similarity exhibited by the uropods.
(4) The similarity that exists between the structure of the telson of the female of *D. asiatica* and the telson of both sexes of *D. australis*.

The main difference between the two species is to be found in the telson of the males. Whereas in *Dimorphostylis australis* there is apparently little difference between the telson in the two sexes, in *D. asiatica* there is a great difference, the male possessing quite a large post-anal portion which is absent in the female. It should be pointed out that, although the telson of *D. australis* is very like that of the female of *D. asiatica*, it is much longer and bears approximately the same relation in proportion to the uropods as does that of the male in *D. asiatica*.

It appears, therefore, that the marked sexual dimorphism, which is one of the most marked characters of *Dimorphostylis asiatica*, and indeed the character which gave the name to the genus, is not a noticeable character of *D. australis*—a form that has to be placed in this genus for other reasons.

Nannastacidae.

Nannastacus, Bate.

12. *Nannastacus suhmii*, G. O. Sars.

N. suhmii, G. O. Sars, 1886.
N. suhmii, Stebbing, 1913.
N. suhmi, Zimmer, 1921 *a*.

Occurrence.—1st October, 1928, and 29th November, 1928, Low Isles Anchorage.

Remarks.—Only males were taken ; their average length is 2·3 mm. Although the specimens are poorly preserved I do not doubt that they belong to this species. The only member of this genus previously described from Australian waters is *N. nasutus*, Zimmer (1914), and this record is from South Australia ; *N. nasutus* and *N. suhmii* are very dissimilar.

In his description of the male of *Nannastacus suhmii*, Sars states that the flagellum of the second antenna does not extend further backward than the third segment of the abdomen. The Barrier Reef specimens have this flagellum extending as far as the last abdominal segment. I have re-examined the " Challenger " type-specimens which have been dismounted by Dr. Calman (see Calman, 1905), and it is quite clear that the antennal flagella do extend the whole length of the abdomen ; the same is the case in the specimens of the " Siboga " Expedition referred to this species by Dr. Calman (*loc. cit.*).

Cumella, G. O. Sars.

13. *Cumella*, sp.

Occurrence.—28th June, 1929, Low Isles Anchorage.

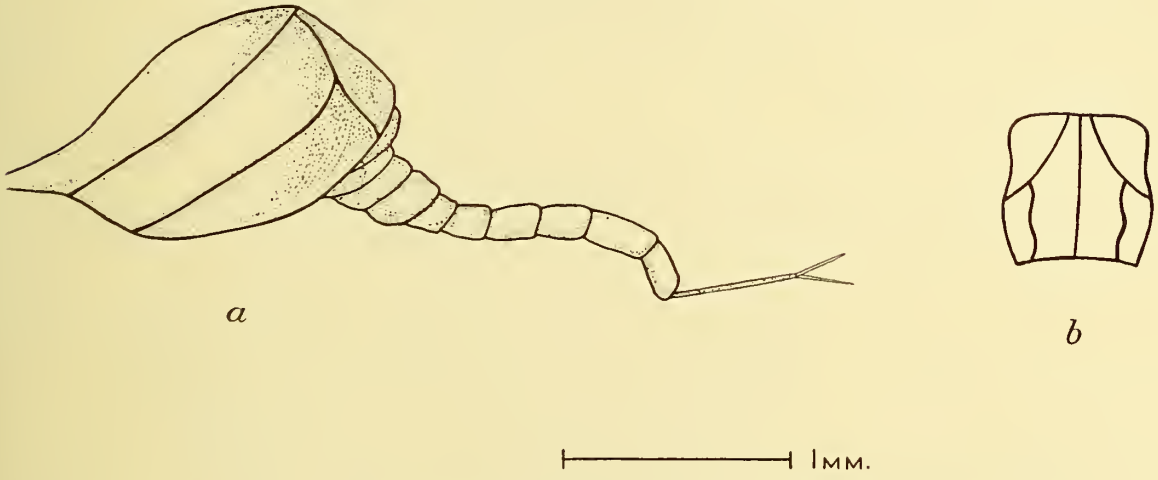
Remarks.—In general appearance this species resembles *Cumella cyclaspoides*, Zimmer (1914), but the uropods are distinctly longer.

I have not attempted to describe this species as no female specimens are present in the collection, and in the light of Dr. Calman's remarks (1911) little purpose would be served by a description based on the male forms only.

Campylaspididae.

Campylaspis, G. O. Sars.

14. *Campylaspis pileus*, n.sp. (Text-figs. 9 and 10.)

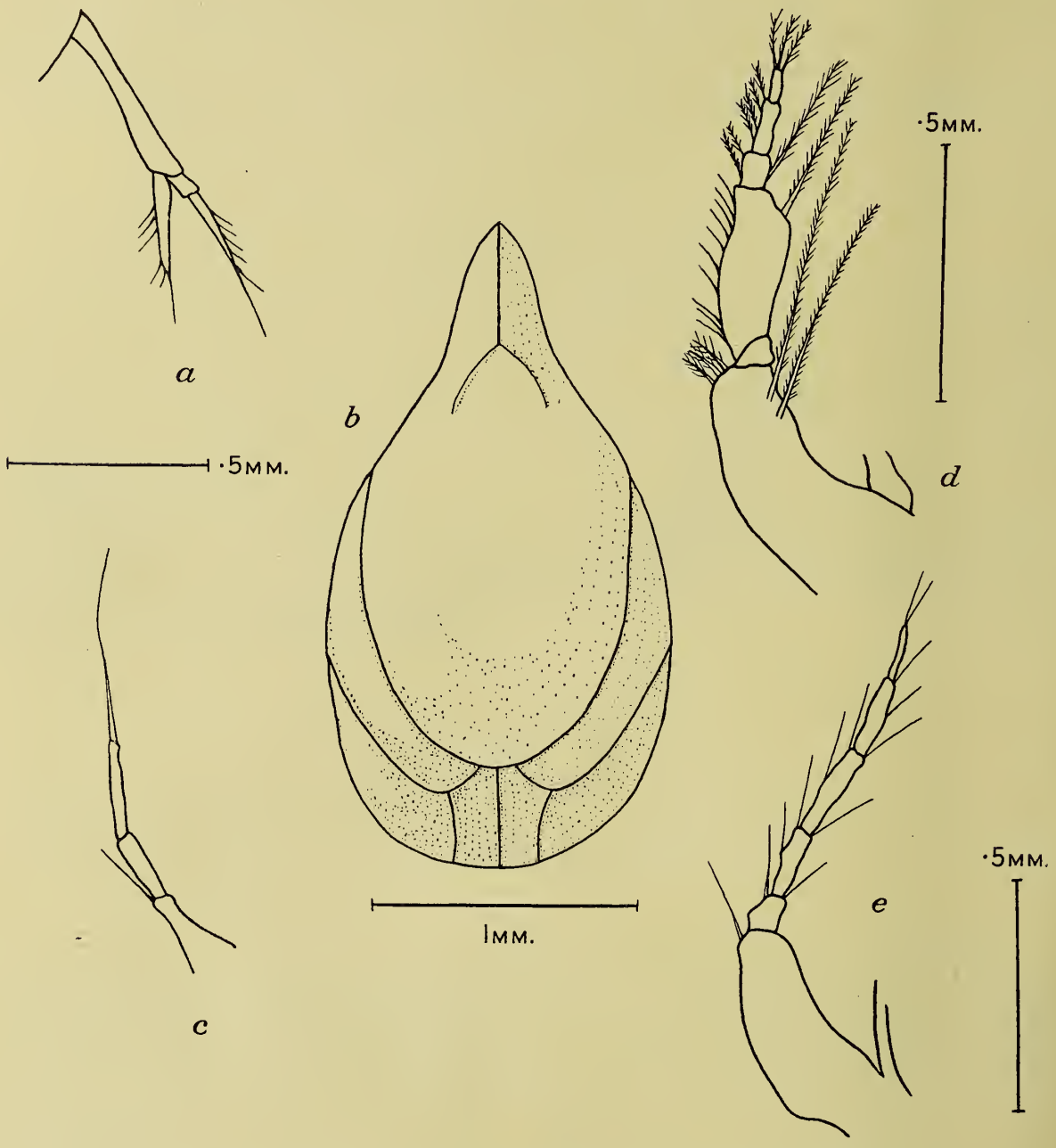


Text-fig. 9.—*Campylaspis pileus*, n. sp. *a*, Lateral view of female, the appendages omitted; *b*, the carapace from the rear.

Occurrence.—Stations XXI and XXIX.

Description of a Female 3·5 mm. in Length.—The carapace (Text-figs. 9, *b*, and 10, *c*) is a little less than half the total length; it is very broad, and dorsally it has a large flattened area marked off by a strong keel, which extends round the carapace from below the pseudorostral lobe on one side to a similar position on the other. Externally to this first keel the carapace inclines sharply downwards, so that the sides of the carapace are nearly at right-angles to the dorsal surface. Half-way between the first keel and the margin of the carapace there is a second keel; laterally it is parallel to the first keel, but posteriorly it turns upwards and meets the first keel quite close to the middle line. On each side of the carapace a third keel extends from the middle of the curve of the second keel to the posterior edge of the carapace. In the middle of the approximately triangular area of the carapace produced on the posterior surface by the intersections of these keels, a fourth keel extends from the most posterior point of the first keel to the hinder margin of the carapace. The fourth keel is not as well defined as are the others.

The pseudorostral lobes are very large, and project far in advance of the ocular lobe. There is no distinct eye and no pigment is present. The integument of the carapace is roughly pitted, but except for the keels there is no marked sculpturing.



TEXT-FIG. 10.—*Campylaspis pileus*, n. sp. *a*, Uropod of female; *b*, carapace, dorsal view; *c*, first antenna of female; *d*, third maxilliped of female; *e*, first leg of female.

The thorax is quite small and slender; all the leg-bearing segments are free, but dorsally they are obscured by the large posterior extension of the carapace.

The abdomen is very slender, the fifth segment being the longest and the pentagonal sixth segment the shortest.

In the Uropods (Text-fig. 10, *a*) the peduncle is twice as long as the sixth segment of the abdomen; the subequal rami are three-fourths the length of the peduncle. The uropods are armed with a few stout spines; there are five on the endopod, four on the exopod and seven smaller spines on the peduncle, but these numbers appear to be subject to variation.

The antennule (Text-fig. 10, *c*) has the accessory flagellum very small.

In the first leg (Text-fig. 10, *e*) the basis is three-fourths the length of the remaining joints; the ischium is small, being half the length of the merus; the carpus is one-fourth longer than the merus. The merus and propodus are equal in length, and the dactylus is equal to two-thirds the length of the propodus. There are many hairs on each segment of the limb.

Remarks.—This species bears certain resemblances to *Campylaspis vitrea*, Calman (1906), but the carapace is not so highly vaulted in *C. pileus* as it is in *C. vitrea*, though there is a general similarity in the arrangement of the keels. There is also some resemblance between *C. pileus* and *C. ovalis*, Stebbing (1912), but they differ in that the greatest breadth of the carapace in *C. ovalis* is in the anterior portion whilst in *C. pileus* it is two-thirds of the way back, being well inside the posterior half of the carapace when viewed dorsally.

CLADOCERA.

The Cladocera are represented in the collections by one species only, and specimens only occurred for a short time during the year.

15. *Evadne tergestina*, Claus.

E. tergestina, Claus, 1877.
E. aspinosa, Krämer, 1895.
E. gibsoni, Brady, 1914.

Occurrence.—This species occurred at the weekly station during December, 1928, and January and February of 1929 (Stations XXXII—XLII inclusive). It was not taken at any other locality.

Remarks.—Several of the specimens tend to confirm Dr. Calman's opinion that *E. gibsoni*, Brady, is synonymous with this species, as they show a deep cervical groove such as Brady described. In all cases this appeared to be due to uneven contraction of the body away from the carapace. The best figures of this species are those given by Krämer under the synonym of *E. aspinosa*.

Previous records for this species are: N. Atlantic and Mediterranean (Hansen, 1899), S. Atlantic (Calman, 1917; Hansen, *loc. cit.*), Californian Coast (Juday, 1907), Indian Ocean (Hansen, *loc. cit.*), Australian waters (Hansen, *loc. cit.*; Krämer, 1895), New Zealand (Krämer, *loc. cit.*), and S. Africa (Brady, 1914).

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